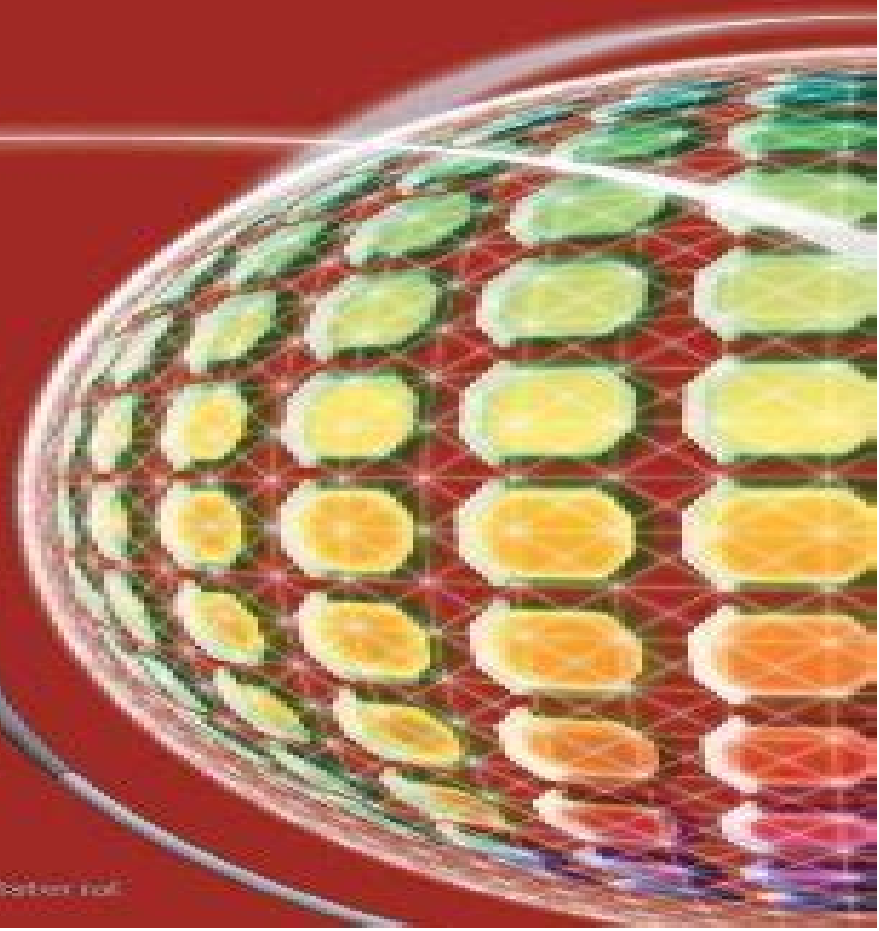




Survivable Optical WDM Networks

Canhui (Sam) Ou
Biswanath Mukherjee



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Survivable Optical Wdm Networks:

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Survivable Optical WDM Networks Canhui (Sam) Ou, Biswanath Mukherjee, 2010-07-19 Survivable Optical WDM Networks investigates different approaches for designing and operating an optical network with the objectives that 1 more connections can be carried by a given network leading to more revenue and 2 connections can recover faster in case of failures leading to better services Different networks wavelength routed WDM networks wavelength routed WDM networks with sub wavelength granularity grooming and data over next generation SONET SDH over WDM networks are covered Different approaches are proposed to explore every aspect of a protection scheme such as 1 Protection granularity a At wavelength granularity b At sub wavelength granularity 2 Protection entity a Path protection b Sub path protection c Segment protection 3 Routing a Single path routing b Multi path routing Tradeoffs between different objectives e g resource efficiency vs recovery time are explored and practical approaches are proposed and analyzed

Optical Networks Hussein T. Mouftah, Pin-Han Ho, 2003 Special emphasis has been given to the design of meshed middle sized and wavelength routed networks with dynamic traffic in the optical domain such as the next generation Metropolitan Area Network

Design and Analysis of Survivable Wdm Optical Network Minjing Mao, 2017-01-26 This dissertation Design and Analysis of Survivable WDM Optical Network by Minjing Mao was obtained from The University of Hong Kong Pokfulam Hong Kong and is being sold pursuant to Creative Commons Attribution 3.0 Hong Kong License The content of this dissertation has not been altered in any way We have altered the formatting in order to facilitate the ease of printing and reading of the dissertation All rights not granted by the above license are retained by the author

Abstract Optical networks with Wavelength Division Multiplexing WDM technology provide huge bandwidth to meet the ever increasing traffic demand of the next generation Internet But the high speed nature of WDM networks also makes the network more vulnerable to failures Even a single network failure for a very short duration can result in enormous loss of data In this thesis we concentrate on designing a survivable WDM network In essence survivability concerns two important aspects fast fault detection and localization and fast fault recovery We first study fast fault detection and localization in WDM optical networks Our work is based on the notion of monitoring cycle m cycle Compared with other fault detection schemes an m cycle based fault detection scheme provides fast fault detection and requires less number of expensive monitors Aiming at further cutting down the implementation cost we propose the notion of super monitor Instead of having a dedicated monitor for each m cycle a single super monitor can be placed at the junction of a set of overlapped m cycles In this thesis we formulate and solve the monitor placement problem We then focus on enhancing the capacity efficiency of fast fault recovery schemes Shared backup path protection SBPP schemes can provide 100% protection against any single link failure This is

achieved by establishing a pair of link disjoint active and backup paths upon each call arrival The bandwidth on different backup paths can be shared for protecting different calls In this thesis a new SBPP scheme is designed based on a two step routing approach where the active and backup paths are sequentially optimized with different objectives in mind We then shift our focus to design fast protection scheme for multicast broadcast communications To this end we refine the existing concept of blue red tree Blue red tree is a pair of spanning trees where the connectivity between the root and any destination node is ensured upon a network failure In particular two efficient integer linear programs ILPs are formulated for finding the optimal blue red trees Last but not the least we investigate the survivability in IP networks We notice that existing efforts on IP fast reroute IPFRR are effective in enhancing the IP resilience But the impact of IPFRR on the end to end TCP performance is ignored Notably path rerouting can interfere with the TCP congestion control mechanism and thus cause severe throughput degradation To address this problem we propose a duplicate acknowledgement ACK suppression scheme The key idea is to detect whether an out of order packet arrival event is due to IPFRR or not If it is due to IPFRR duplicate ACKs triggered will be suppressed by the TCP receiver so as not to cause unnecessary slow down at the TCP sender DOI 10.5353/th_b4784968

Subjects Wavelength division multiplexing Optical communications Design and construction

Power Source Aware Survivable Optical WDM Networks Mark Boddie,2013

Survivability and Traffic Grooming in WDM Optical Networks Arun Somani,2006-01-12 This book provides coverage of survivability and traffic grooming two key issues in modern optical networks

Reliability, Survivability and Quality of Large Scale Telecommunication Systems Peter Stavroulakis,2003-09-11 Competition within the telecommunications companies is growing fiercer by the day Therefore it is vital to ensure a high level of quality and reliability within all telecommunications systems in order to guard against faults and the failure of components and network services Within large scale systems such quality and reliability problems are ever higher The metrics of Quality and Reliability have to date only been available in journals and technical reports of companies which have designed or produced major parts of systems used in large applications This book provides a self contained treatment enabling the reader to be able to produce define and utilise the metrics of Quality and Reliability required for the design and implementation of a large application such as a world class event as the Olympic Games An additional outcome is that this book can be used as a guide for producing an ISO standard for large scale Systems such as the Olympic Games Provides presentations of techniques used for solving quality and reliability problems in telecommunications networks replete with illustrations of their applications to real world services and world class events Individual chapters written by respective international experts within their fields This will prove highly informative for Practising engineers researchers and telecommunications professionals academics and graduate students in telecommunications standards bodies and organisations such as ISO

Design and Analysis of Survivable Optical Networks Canhui (Sam) Ou,2004

Survivability Approaches for Multiple Failures in WDM Optical Networks Pallab Datta,2005 The explosive growth

of Web related services over the Internet is bringing millions of new users online thus fueling an enormous demand for bandwidth Wavelength Division Multiplexed WDM networks employing wavelength routing have emerged as the dominant technology to satisfy this growing demand for bandwidth As the amount of traffic carried has increased any single failure can be catastrophic Survivability becomes indispensable in such networks Therefore it is imperative to design networks that can quickly and efficiently recover from failures Most research to date in survivable optical network design and operation focuses on single link failures however the occurrence of multiple link failures are not uncommon in a network topology Multi link failure scenarios can arise out of two common situations First an arbitrary link may fail in the network and before that link can be repaired another link fails thus creating a multi link failure sequence Secondly it might happen in practice that two distinct physical links may be routed via the same common duct or physical channel A failure at that shared physical location creates a logical multiple link failure Such instances where separate fiber optic links share a common failure structure is often referred to as SRLG Shared Risk Link Groups In this dissertation we study survivability paradigms for surviving multiple link failures We study the network design and upgrade problem in WDM backbone networks and formulate it using a simulated annealing based technique This framework provides a cost effective way of upgrading the network by identifying how much resources to budget at each stage of network evolution This results in significant cost reductions for the network service provider We study protection reconfiguration using two different survivability paradigms namely sub graph routing and shared mesh protection Initially sub graphs are defined taking into account link SRLG or node failures and could in the event of an unrelated or subsequent multi link failure incorporate the reactive form of sub graph fault tolerance Reactive sub graph fault tolerance employs a recursive approach for tolerating numerous sequential overlapping failures It can tolerate simultaneous multiple link failures by simply serializing the handling of each individual fault Connection re routing and network reconfiguration is one of the primary challenges in sub graph routing methodology We propose a constrained subgraph routing methodology which restricts the connections to be routed using the same trunk and channel in the subgraphs thus minimizing reconfiguration The subgraph based routing methodology is further explored to tolerate multiple link failures in the form of shared risk link groups and node failures The generalized diverse routing problem for finding two diverse routes between a source and destination has been shown to be NP Complete Recent studies have also proven the NP completeness of the SRLG diverse routing We propose a polynomial time graph transformation algorithm for solving the diverse routing problem for certain specific SRLG s which includes link sets incident on a common node The proposed graph transformation methodology for diverse routing is also studied for shared risk node group SRNG failures

Emerging Optical Network Technologies Krishna M. Sivalingam, Suresh Subramaniam, 2006-01-16 Optical networks have moved from laboratory settings and theoretical research to real world deployment and service oriented explorations New technologies such as Ethernet PON traffic grooming regional and metropolitan network architectures and optical packet

switching are being explored and the landscape is continuously and rapidly evolving Some of the important issues involving these new technologies involve the architectural protocol and performance related issues This book addresses many of these issues and presents a birds eye view of some of the more promising technologies Researchers and those pursuing advanced degrees in this field will be able to see where progress is being made and new technologies are emerging Emerging Optical Network Technologies Architectures Protocols and Performance provides state of the art material written by the most prominent professionals in their respective areas

WDM and Photonic Networks D. W. Faulkner, Alan Harmer, 2000
Volume 1 WDM and Photonic Networks will focus on recent developments in long haul WDM and photonic networks and will include invited papers from key vendors and technologists A paper on DWDM by Lucent will show how Raman amplification enables the quadrupling of the line rate from OC 192 to OC 768 in a recent 1.6Tb/s experiment

Advances in Evolutionary Computing for System Design Vasile Palade, Dipti Srinivasan, 2007-07-07 Evolutionary computing paradigms offer robust and powerful adaptive search mechanisms for system design This book's thirteen chapters cover a wide area of topics in evolutionary computing and applications including an introduction to evolutionary computing in system design evolutionary neuro fuzzy systems and evolution of fuzzy controllers The book will be useful to researchers in intelligent systems with interest in evolutionary computing as well as application engineers and system designers

Optical Networks and Components Partha Pratim Sahu, 2022-07-30 Intended as an undergraduate post graduate level textbook for courses on high speed optical networks as well as computer networks Nine chapters cover basic principles of the technology and different devices for optical networks as well as processing of integrated waveguide devices of optical networks using different technologies It provides students researchers and practicing engineers with an expert guide to the fundamental concepts issues and state of the art developments in optical networks Includes examples throughout all the chapters of the book to aid understanding of basic problems and solutions

e-Business and Telecommunication Networks João Ascenso, Luminita Vasiu, Carlos Belo, Mónica Saramago, 2006-08-18 This book contains the best papers of the First International Conference on e Business and Telecommunication Networks held in 2004 The book presents recent research on e business and telecommunication networks It includes analyses aspects of global communication information systems and services and describes security and reliability problems and solutions in information systems and networks

New Trends in Optical Network Design and Modeling Alexandros A. Stavdas, 2013-03-09 Optical network design and modeling is an essential issue for planning and operating networks for the next century The main issues in optical networking are being widely investigated not only for WDM networks but also for optical TDM and optical packet switching This book contributes to further progress in optical network architectures design operation and management and covers the following topics in detail Optical switching and Teabit networking Future OTDM and packet switched networks WDM ring networks Optical interworking and packets over wavelength Hybrid and switchless networks Medium access protocols for optical LANs and

MANs This book contains the selected proceedings of the Fourth International Working Conference on Optical Network Design and Modeling which was sponsored by the International Federation for Information Processing IFIP and held in February 2000 in Athens Greece This valuable new book will be essential reading for academic researchers and practitioners working in computer science electrical engineering and communications

Path Routing in Mesh Optical Networks Eric Bouillet, Georgios Ellinas, Jean-Francois Labourdette, Ramu Ramamurthy, 2007-10-24 Transport networks evolved from DCS Digital Cross connect Systems based mesh architectures to SONET SDH Synchronous Optical Networking Synchronous Digital Hierarchy ring architectures in the 1990 s In the past few years technological advancements in optical transport switches have allowed service providers to support the same fast recovery in mesh networks previously available in ring networks while achieving better capacity efficiency and resulting in lower capital cost Optical transport networks today not only provide trunking capacity to higher layer networks such as inter router connectivity in an IP centric infrastructure but also support efficient routing and fast failure recovery of high bandwidth services This is possible due to the emergence of optical network elements that have the intelligence required to efficiently control the network Optical mesh networks will enable a variety of dynamic services such as bandwidth on demand Just In Time bandwidth bandwidth scheduling bandwidth brokering and optical virtual private networks that open up new opportunities for service providers and their customers alike Path Routing in Mesh Optical Networks combines both theoretical as well as practical aspects of routing and dimensioning for mesh optical networks All authors have worked as technical leaders for the equipment vendor Tellium who implemented such capabilities in its product and whose product was deployed in service provider networks Path Routing in Mesh Optical Networks Presents an in depth treatment of a specific class of optical networks i e path oriented mesh optical networks Focuses on routing and recovery dimensioning performance analysis and availability in mesh optical networks Explains and analyses routing specifically associated with Dedicated Backup Path Protection DBPP and Shared Backup Path Protection SBPP recovery architectures As most of the core backbone networks evolve to mesh topologies utilizing intelligent network elements for provisioning and recovery of services Path Routing in Mesh Optical Networks will be an invaluable tool for both researchers and engineers in the industry who are responsible for designing developing deploying and maintaining mesh optical networks It will also be a useful reference book for graduate students and university professors who are interested in optical networks or telecommunications networking With a foreword by Professor Wayne D Grover author of the book Mesh Based Survivable Networks

Encyclopedia of Internet Technologies and Applications Freire, Mario, Pereira, Manuela, 2007-10-31 Provides the most thorough examination of Internet technologies and applications for researchers in a variety of related fields For the average Internet consumer as well as for experts in the field of networking and Internet technologies

Technological Developments in Networking, Education and Automation Khaled Elleithy, Tarek Sobh, Magued Iskander, Vikram Kapila, Mohammad A. Karim, Ausif Mahmood, 2010-06-18 Technological Developments in

Networking Education and Automation includes a set of rigorously reviewed world class manuscripts addressing and detailing state of the art research projects in the following areas Computer Networks Access Technologies Medium Access Control Network architectures and Equipment Optical Networks and Switching Telecommunication Technology and Ultra Wideband Communications Engineering Education and Online Learning including development of courses and systems for engineering technical and liberal studies programs online laboratories intelligent testing using fuzzy logic taxonomy of e courses and evaluation of online courses Pedagogy including benchmarking group learning active learning teaching of multiple subjects together ontology and knowledge management Instruction Technology including internet textbooks virtual reality labs instructional design virtual models pedagogy oriented markup languages graphic design possibilities open source classroom management software automatic email response systems tablet pcs personalization using web mining technology intelligent digital chalkboards virtual room concepts for cooperative scientific work and network technologies management and architecture Coding and Modulation Modeling and Simulation OFDM technology Space time Coding Spread Spectrum and CDMA Systems Wireless technologies Bluetooth Cellular Wireless Networks Cordless Systems and Wireless Local Loop HIPERLAN IEEE 802 11 Mobile Network Layer Mobile Transport Layer and Spread Spectrum Network Security and applications Authentication Applications Block Ciphers Design Principles Block Ciphers Modes of Operation Electronic Mail Security Encryption Message Confidentiality Firewalls IP Security Key Cryptography Message Authentication and Web Security Robotics Control Systems and Automation Distributed Control Systems Automation Expert Systems Robotics Factory Automation Intelligent Control Systems Man Machine Interaction Manufacturing Information System Motion Control and Process Automation Vision Systems for human action sensing face recognition and image processing algorithms for smoothing of high speed motion Electronics and Power Systems Actuators Electro Mechanical Systems High Frequency Converters Industrial Electronics Motors and Drives Power Converters Power Devices and Components and Power Electronics

Communication in Transportation Systems Strobel, Otto, 2013-02-28 Typically communication technology breakthroughs and developments occur for the purposes of home work or cellular and mobile networks Communications in transportation systems are often overlooked yet they are equally as important Communication in Transportation Systems brilliantly bridges theoretical knowledge and practical applications of cutting edge technologies for communication in automotive applications This reference source carefully covers innovative technologies which will continue to advance transportation systems Researchers developers scholars engineers and graduate students in the transportation and automotive system communication electrical and information technology fields will especially benefit from this advanced publication

Fundamentals of Optical Networks and Components Partha Pratim Sahu, 2020-07-09 This book is intended as an undergraduate postgraduate level textbook for courses on high speed optical networks as well as computer networks Nine chapters cover the basic principles of the technology and different devices for optical networks as well as processing of

integrated waveguide devices of optical networks using different technologies It provides students researchers and practicing engineers with an expert guide to the fundamental concepts issues and state of the art developments in optical networks It includes examples throughout all the chapters of the book to aid understanding of basic problems and solutions Presents basics of the optical network devices and discusses latest developments Includes examples and exercises throughout all the chapters of the book to aid understanding of basic problems and solutions for undergraduate and postgraduate students Discusses different optical network node architectures and their components Includes basic theories and latest developments of hardware devices with their fabrication technologies such as optical switch wavelength router wavelength division multiplexer demultiplexer and add drop multiplexer helpful for researchers to initiate research on this field and to develop research problem solving capability Reviews fiber optic networks without WDM and single hop and multi hop WDM optical networks P P Sahu received his M Tech degree from the Indian Institute of Technology Delhi and his Ph D degree in engineering from Jadavpur University India In 1991 he joined Haryana State Electronics Development Corporation Limited where he has been engaged in R D works related to optical fiber components and telecommunication instruments In 1996 he joined Northeastern Regional Institute of Science and Technology as a faculty member At present he is working as a professor in the Department of Electronics and Communication Engineering Tezpur Central University India His field of interest is integrated optic and electronic circuits wireless and optical communication clinical instrumentation green energy etc He has received an INSA teacher award instituted by the highest academic body Indian National Science Academy for high level of teaching and research He has published more than 90 papers in peer reviewed international journals 60 papers in international conference and has written five books published by Springer Nature McGraw Hill Dr Sahu is a Fellow of the Optical Society of India Life Member of Indian Society for Technical Education and Senior Member of the IEEE

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